Enhancing students' attitude towards statistics as a tool for building an egalitarian society

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Abstract

This paper analyses the impact of an innovative educative project about teaching and learning data analytics (DA) on secondary students' attitude towards statistics. The main objective of this research is to contribute on the improvement of students' attitude and motivation towards learning statistics. A total of 113 students, aged 14-17, participated in this study. Students solved in small groups a social challenge related how weather affects our lives. During the project, students developed key DA (i.e. define problem, explore and analyse data, draw conclusions and make decisions) and they learned to draw evidence-based conclusions to the question 'How does weather affect us?' A pre-post attitude questionnaire towards statistics was built, validated and used in this study.

A likert scale questionnaire of 22 questions was adapted and validated and used to evaluate students' attitude towards statitiscs. The questions were adapted from four well-known and already validated questionnaires and were divided into six dimensions (cognitive competence, technology cognitive competence, learning statistics with technology, affect, self-confidence and anxiety). Our findings show a significant improvement of attitudes towards statistics in the posttest in comparison with the pretest. Statistical knowledge will lead our students to take evidence-based decisions in order to construct a more egalitarian and social justice world.

Proposal Information/Research/Questions and Theoretical Approach

Many studies indicate a negative attitude of students towards statistics and this issue may obstruct their academic achievement in maths (Emmioğlu & Capa-Aydin, 2012; Ramirez, Schau, & Emmioğlu, 2012). Ramirez et al. (2012) literature revision showed empirical evidence about the strong links between attitudes and academic performance: positive attitudes lead to higher academic performance.

This research is part of a larger EU ERASMUS+ project entitled Strategic Partnership for Innovation in Data Analytics in Schools (SPIDAS), that aims to turn students into critical citizens through Data Analytics (henceforth DA) skills. Our research proposal has defined DA as a process of "engaging creatively in exploring data to understand our world better, draw conclusions, make decisions and predictions, and critically evaluate present/future courses of actions" (Cooper, 2012; Fujita, Kazak, Pifarré & Mansour, 2018). Based on the DA learning, we pretend to empower students with analytical thinking and thus, be more able to analyse and find solutions to real social problems. In order to collect and analyse their data, students used technology (Excel, CODAP...). In this respect, Basturk (2005) showed benefits of using computer-assisted instruction in a statistics course. Students that attended this statistics technology-enhanced course reached significantly higher scores than the control group. Educational literature also reports positive impacts on students' learning about statistics when project-based learning is used and real-life problems are

stated (Lawson, Schwiers, Doellman, Grady, & Kelnhofer, 2003; Schoenfelder, Olson, Bell, & Tom, 2007; Wiberg, 2009). Our study pretends to bring more scientific evidences that may support that the implementation of student-centred and project-based learning can be valuable teaching approaches for enhancing positive students' attitudes towards statistics.
The objective of this study was therefore to adapt and validate an attitude questionnaire capable to measure students' attitudes towards statistics. If students are more engaged with statistics, they will be more aware and motivated about the importance of the data for understanding our globalized world. Understanding the social issues through a more accurate interpretation of the data will help in finding appropriate decisions and responses. Without doubt, to know how to deal with data, students need to be equipped with DA skills.

Methods

Participants

113 students (14 / 17 year-old), from three secondary schools.

Methodological approach

We have designed, implemented and evaluated a series of classroom-based projects in secondary education that embedded the DA cycle to solve real challenges about the weather.
The evaluation of students' attitudes towards statistics was done by using a Likert scale questionnaire of 22 questions. The questions were selected and adapted from 4 validated questionnaires: SASTSc (2011), SATS (1995; 2003), STATS-A (1992), SATSQ (2005) (Nolan, Beran & Hecker, 2012). The purpose of the questions is cover the next six key dimensions of our study: cognitive competence, technology cognitive competence, learning statistics with technology, affect, self-confidence and anxiety. SPSS statistics software was used to analyse reliability of questionnaire. The Cronbach's alpha was 0.88. Relating to the content validity, a Delphi method (Hsu & Sandford, 2007) was followed to obtain the opinion of an expert's panel about the questionnaire items.

Conclusions & Findings, Scientific significance

Students' answered the attitude questionnaire before (pre-test) and after (post-test) they attended the innovative DA classroom projects. The results show a positive impact of the educative intervention on students'attitude towards statistics. Wilcoxon Signed-Ranks test shows a statistically significant improvement (p<.001) in the post-test ($\bar{x}$=67.70; SD=10.16) in relation to the results of the pre-test ($\bar{x}$=62.57; SD=10.39). Posttest ranks are statistically significantly higher than pretest ranks (Z =4.048, p <.001).
Analysing separately each one of the six dimensions of the questionnaire, the results show that students improved in all the dimensions of the questionnaire. Furthermore, Wilcoxon Signed-Ranks test displays that this increment is statistically significant in the dimensions of **cognitive competence** (Z =3.784, p <.001), **technology cognitive competence** (Z =3.587, p <.001), **learning statistics with technology** (Z =3.195, p <.002), **affect** (Z =2.574, p <.05) and **anxiety** (Z =2.702, p <.05). A meta-analysis result revealed that generally, statistics achievement has higher correlations with Cognitive Competence and Affect (Emmioğlu & Capa-Aydin, 2012).
In this line of argument, Konold & Miller (2015) claimed that technology (such TinkerPlots) can help students to structure their data in different ways of visualizing statistical models through its dynamic visualization features and this may have an impact on students' confidence in using statistics to successfully solve problems.

Indeed, these competences will lead our students to take evidence-based decisions in order to construct a more egalitarian and social justice world. They will have more critical capacity and more possibilities to participate in a globalized world.

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References

Basturk, R. (2005). The effectiveness of computer-assisted instruction in teaching introductory statistics. *Educational Technology & Society*, 8, 170-178. Retrieved from http://www.ifets.info/journals/8_2/16.pdf

Cooper, A. (2012). What is analytics? Definition and essential characteristics. *CETIS Analytics Series, 1*(5), 1-10.

Emmioğlu, E., & Capa-Aydin, Y. (2012). Attitudes and achievement in statistics: A metaanalysis study. *Statistics Education Research Journal, 11*(2), 95-102. Retrieved from https://iase-web.org/documents/SERJ/SERJ11(2)_Emmioglu.pdf

Fujita, T., Kazak, S., Pifarre, M. & Mansour, N. (2018). *The State of Art Review. Strategic partnership for Innovative in Data Analytics in Schools* [PDF file]. Recuperado de http://blogs.exeter.ac.uk/spidasatexeter/io1-state-of-art-review/

Hsu, C. C., & Sandford, B. A. (2007). The Delphi technique: making sense of consensus. *Practical assessment, research & evaluation, 12*(10), 1-8.

Konold, C., and Miller, C. (2015), TinkerPlotsTM Version 2.2 [computer software], Learn Troop. Available at http://www.tinkerplots.com/

Lawson, T. J., Schwiers, M., Doellman, M., Grady, G., & Kelnhofer, R. (2003). Enhancing students' ability to use statistical reasoning with everyday problems. *Teaching of Psychology, 30*(2), 107-110. doi:10.1207/S15328023TOP3002_04

Ramirez, C., Schau, C., & Emmioğlu, E. (2012). The importance of attitudes in statistics education. *Statistics Education Research Journal, 11*(2), 57-71. Retrieved from https://iase-web.org/documents/SERJ/SERJ11(2)_Ramirez.pdf

Schoenfelder, E., Olson, R., Bell, M., & Tom, K. (2007). Stop and smell the roses: An activity for teaching the central limit theorem. *Psychology Learning and Teaching, 6*(2), 80-84. doi:10.2304/plat.2007.6.2.80

Wiberg, M. (2009). Teaching statistics in integration with psychology. *Journal of Statistics Education*, *17*(1), 1-16. Retrieved from https://eric.ed.gov/?id=EJ841537